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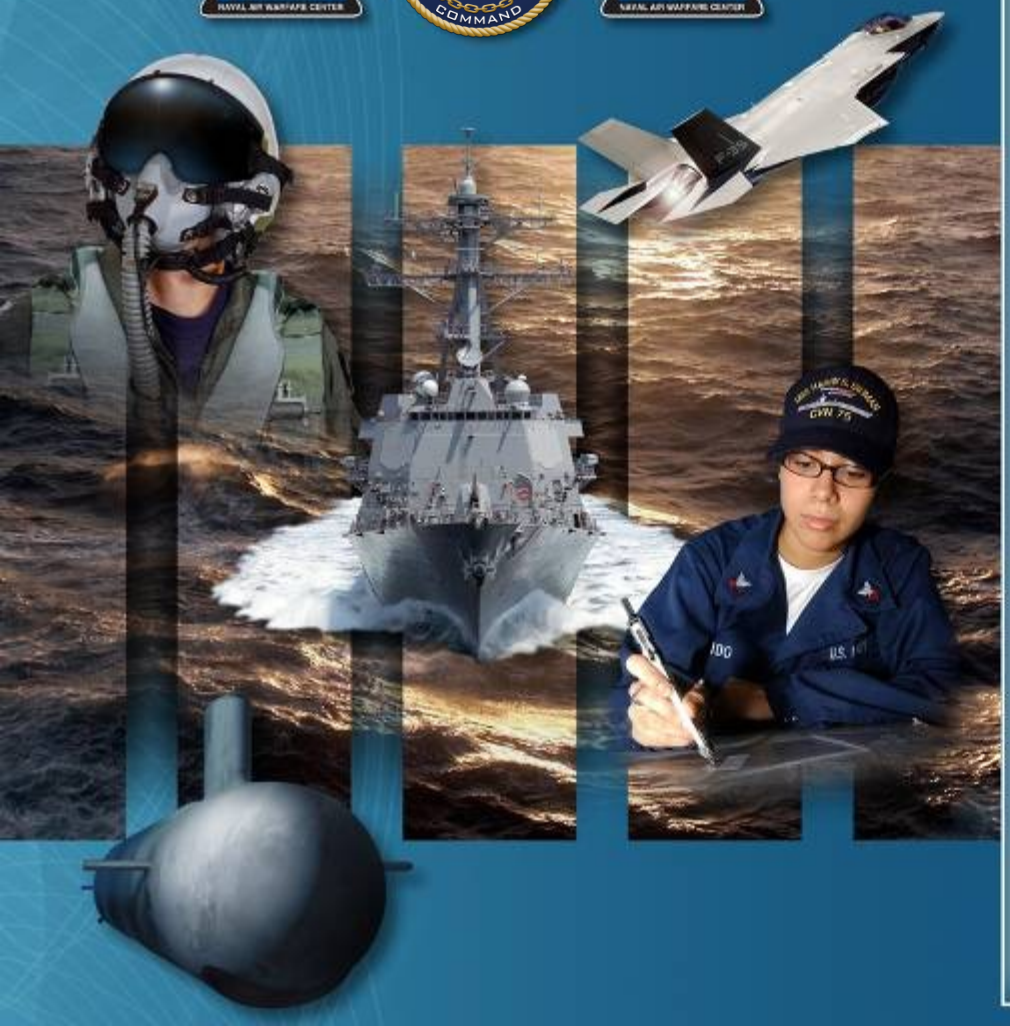

Unmanned Aerial System (UAS) Selection: Validating the Performance Based Measurement (PBM) Battery

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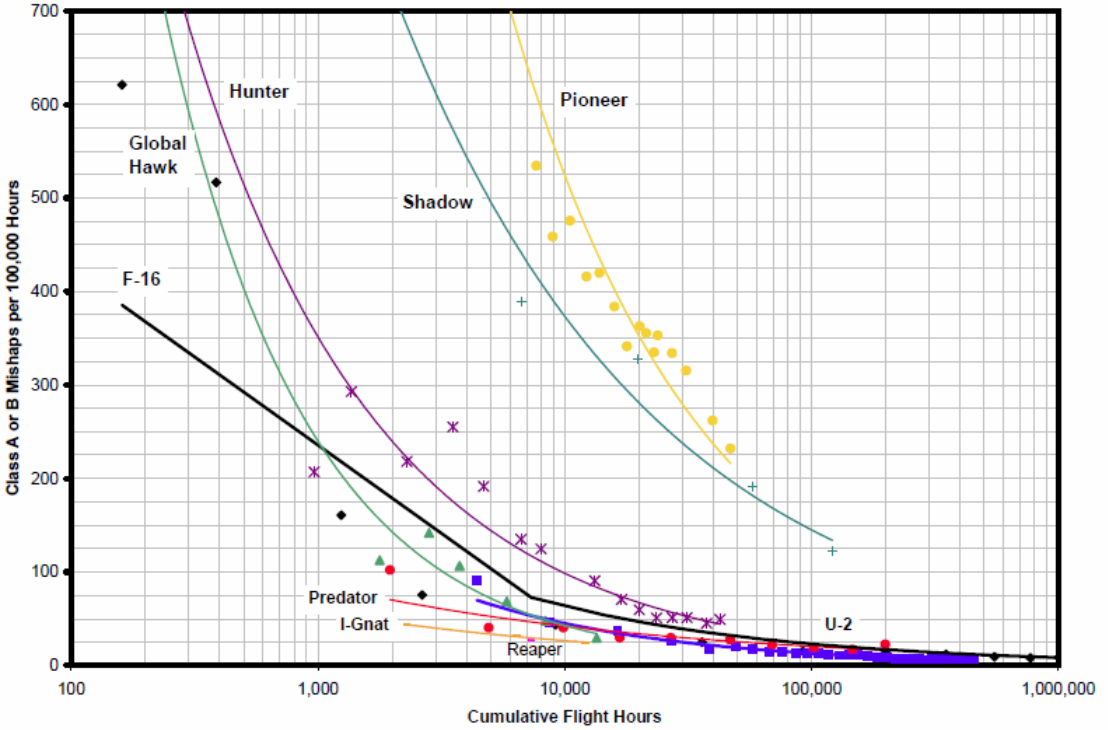
Overview

- Manned & Unmanned Safety Concerns & Mitigation
- UAS Selection Challenges
- Performance Based Measurement Battery
- NAWCTSD Selection Effort
- Content Validation Results & Discussion
- Conclusion

UAS Safety Concerns

U.S. Military Aircraft and UAS Class A Mishap Rates (Lifetime), 1986–2006*



UAV Mishap Causes:

- Human Factors (≈50%)
  (Thompson, et al., 2005**; Williams, 2004)
- Common Issues:
  - Deficient Knowledge, Skills, & Abilities (KSAs)
  - Workload
  - Situational Awareness
  - Decision-making
  - Crew Resource Management

Need Exists to Improve Safety & Mitigate Mishaps

*Office of the Secretary of Defense, 2003
**Thompson, Tvaryanas, & Constable, 2005

Mishap Reduction: Lessons Learned From Manned Aviation

- Naval Aviation Selection Test Battery (ASTB) (11.4% of Variance*)
  - Consists of 6 Cognitive Abilities Tests
    - Reading Skills Test
    - Mathematical Skills Test
    - Mechanical Comprehension Test
    - Spatial Apperception Test
    - Aviation & Nautical Information Test
    - Aviation Supplemental Test
  - Estimated Cost Avoidance of $30M Annually
    (*Navy Aerospace Medical Institute, 2011)
    - Improved Performance & Training Efficiency
    - Reduced Training Attrition (25%)
  - Improved Safety
    - Field Flight Performance Board Appearance Associated with Low ASTB Scores (Grubb & Phillips, 2011)

Providing a Comparable Tool for the UAS Community Could Yield Similar Benefits

UAS Selection Challenges

- Many For Manned Aviation, One For UAS
- Computer Based Performance Test (CBPT) Only Test Ever Validated for UASs
  - Developed & Validated for Legacy System, Pioneer
    - External Pilots: r^2=.86* (Biggerstaff, Blower, Portman, & Chapman, 1998)
    - Internal Pilots: r= .59 (Phillips, Arnold, & Fatolitis, 2003)
  - Highly Predictive But Never Transitioned
  - Standalone System Running On Outdated Operating System
- No Previous Efforts on Cross Platform Selection Tool

Objective: Investigate the Utility/Generalizability of a Manned Aviation Validated Selection Tool (i.e., Performance Based Measurement Battery) for Unmanned Systems

*Adjusted for Small n

Why the PBM?

CBPT (Legacy Pioneer)

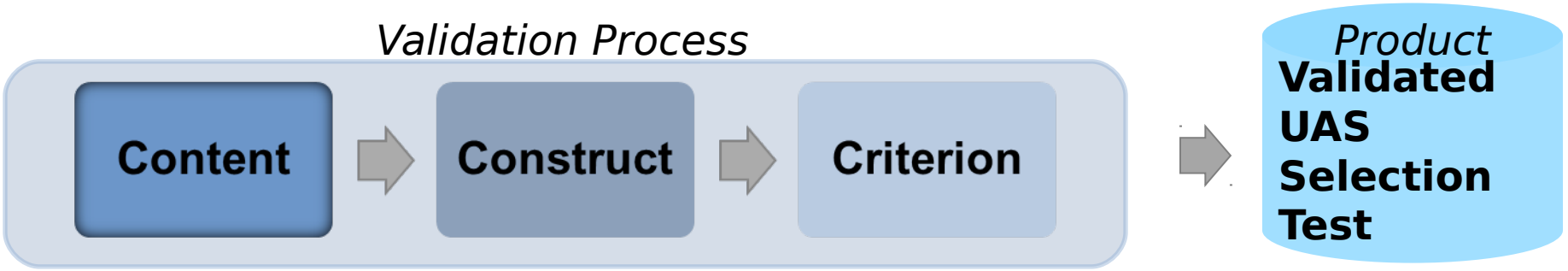
Subtest	Ability
Dichotic Listening Test	• Auditory Processing • Cognitive Processing
Throttle (Vertical Tracking) Test	• Psychomotor
Stick (2-D Tracking) Test	• Psychomotor
Manikin Test	• Spatial Ability • Cognitive Processing
Digit Cancellation Test	• Cognitive Processing
Rudder (Horizontal Tracking) Test	• Psychomotor

PBM (Manned Aviation)

Subtest	Ability
Dichotic Listening Test	• Auditory Processing • Cognitive Processing
Vertical Tracking Test	• Psychomotor
Airplane Tracking (2-D) Test	• Psychomotor
Directional Orientation Test	• Spatial Ability • Cognitive Processing
Emergency Scenario	• General Cognitive • Stress Tolerance

- CBPT Developed for Pioneer, RQ-7 Shadow Replaced Pioneer
  - KSAs Likely to be Similar
  - Other Operationally Similar Platforms Likely to Apply (e.g., Raven, ScanEagle)

NAWCTSD Selection Effort



- 3 Year Effort Underway Exploring Validity of PBM
- Research Goals
  - Identify Leverage Points
    - Validated Subtests for UAS
  - Identify PBM Gaps
    - Additional Subtests for Future Development
- Why Reinvent the Wheel?
    - $5M Program to Add PBM to Next Version of ASTB-E
    - Cost Avoidance

Content Validation: Method

- Relevant KSAs
  - Expanded Mangos et al 67 KSAs
  - 109 KSAs Used
- KSA Assessment Tool Sample Item:

  Identify the degree to which the PBM subtest captured this KSA:

Not at All (0%)	Slightly (20%)	Partially (40%)	Moderately (60%)	Strongly (80%)	Entirely (100%)
1	2	3	4	5	6

- Survey Administration
  - PBM Subtests Taken to Provide Context
  - One KSA Assessment Survey Provided following Each Subtest
- Analysis Method: Two Hurdle Approach
  - Mean Cutoff: 3.5 or Greater
  - Inter-rater Agreement: rwg = .56 or Greater

Content Validation: SME Demographics

- Participating Organizations
  - Navy
    - Naval Air Warfare Center Training Systems Division, Orlando
    - Naval Medical Research Unit – Dayton
  - Air Force
    - Air Force Personnel Center
    - Air Education & Training Command/Air Force Recruiting Service

- 9 Subject Matter Ex

Job Title	n
Research Psychologist/Researcher	5
Senior Research Psychologist	1
Director/Deputy of Research	2

- Experience Type

Experience Type	Mean (months)
UAS	49
Selection	165.9
Training	60.2

Content Validation: Results

Item #	KSA	DOT	DLT	VTT	ATT	VTTATT	MTT	EST
1	Reasoning Skills	X						
2	Aviation Principles	√						
20	Spatial Visualization	√						
22	Reaction Time	X	√					
23	Handling Crisis/Emergency Situations							√
25	Manual Dexterity				X			
27	Perceptual Speed & Accuracy		X					
34	Control Precision			√	√	√	√	√
43	Map Reading	X						
53	Spatial Orientation	√						
56	Mental Rotation	√						
59	Attention Allocation and Control					√	√	√
78	Concentration/Selective Attention		√					
82	Auditory Attention/Localization		√				√	
85	Rate Control			√	√	√	√	√
94	Multilimb Coordination						X	
97	Hand-eye coordination			√	√	X	√	
103	Response Selection		√					√

Result Discussion

- All Subtests Contain 3+ UAS Relevant KSAs
- Some Subtests More UAS Valid Than Others?
  - More Validation Work Required to Understand Predictive Ability
- Limitations
  - Not all SMEs Contained UAS Relevant Domain Knowledge
  - 109 Item KSA Assessment Survey Given 7 Times
    - Fatigue

Future Directions

- Construct Validation Effort
  - 5 Paper-Based Measures, 1 Computer Based
  - Data Collection 50% Complete
- Criterion Validation Effort
  - August 2014
  - Understand Which of the PBM Subtests Predicts Performance for UAS Operators Best
- Additional Human Factors Questions: Optimizing Performance of Trainees through UAS Manpower, Interface, & Selection (OPTUMIS)
  - Who to Select
  - Training
  - Interface Design

Conclusion

- Human Causal Factors Attributed to Mishaps
- Selection Shown to be Beneficial to Manned Aviation
  - Extend to Unmanned
- 3 Year Effort Underway Exploring Validity of PBM
  - Content Validity
    - 3+ KSAs per Subtest
  - Construct Validation Underway
- Further Research Necessary

Questions?

Research Benefits & Limitation

- Benefits
  - Identify Leverage Points
    - Validated Subtests for UAS
  - Identify PBM Gaps
    - Additional Subtests for Future Development
  - Why Reinvent the Wheel?
    - $5M Program to Add PBM to Next Version of ASTB-E
    - Cost Avoidance
- Limitations
  - Does Not Answer All Human Factors Questions
    - Who to Select
    - Training
    - Interface Design
    - CONOPs Issues
      - Operators Not in Theater
      - Control of Multiple Disparate UASs

Goal of Research: Provide a Baseline to Guide Future Research Efforts

Mishap Reduction: Lessons Learned From Manned Aviation

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    - Spatial Apperception Test
    - Aviation and Nautical Information Test
    - Aviation Supplemental Test

Providing a Comparable Tool for the UAS Community Could Yield Similar Benefits

Mishap Reduction: Lessons Learned From Manned Aviation

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Providing a Comparable Tool for the UAS Community Could Yield Similar Benefits

Item #	KSA	mean	r wg	
DOT				
1	Reasoning Skills	3.89	0.448	X
2	Aviation Principles	3.78	0.590	√
20	Spatial Visualization	5.33	0.914	√
22	Reaction Time	4.11	0.190	X
43	Map Reading	3.78	0.248	X
53	Spatial Orientation	4.78	0.676	√
56	Mental Rotation	5.44	0.819	√
DLT				
22	Reaction Time	3.67	0.829	√
27	Perceptual Speed and Accuracy	4.11	0.276	X
78	Concentration/Selective Attention	4.67	0.914	√
82	Auditory Attention/Localization	5.33	0.829	√
103	Response Selection	4.78	0.762	√

Item #	KSA	mean	r wg	
VTT				
34	Control Precision	5.44	0.905	√
85	Rate Control	5.00	0.657	√
97	Hand-eye coordination	4.67	0.657	√
ATT				
25	Manual Dexterity	3.56	0.219	X
34	Control Precision	5.22	0.848	√
85	Rate Control	5.44	0.905	√
97	Hand-eye coordination	5.11	0.790	√
VTTATT				
34	Control Precision	5.33	0.829	√
59	Attention Allocation and Control	3.78	0.676	√
85	Rate Control	5.33	0.829	√
97	Hand-eye coordination	4.00	-0.286	X

Item #	KSA	mean	r wg	
	MTT			
34	Control Precision	5.11	0.619	√
59	Attention Allocation and Control	4.56	-0.038	√
82	Auditory Attention/Localization	4.67	0.571	√
85	Rate Control	5.00	0.743	√
94	Multilimb Coordination	3.56	-0.124	X
97	Hand-eye coordination	4.44	0.305	√
	EST			
23	Handling Crisis/Emergency Situations	3.78	0.676	√
34	Control Precision	5.00	0.829	√
59	Attention Allocation and Control	4.11	0.619	√
85	Rate Control	4.67	0.743	√
103	Response Selection	3.56	0.562	√